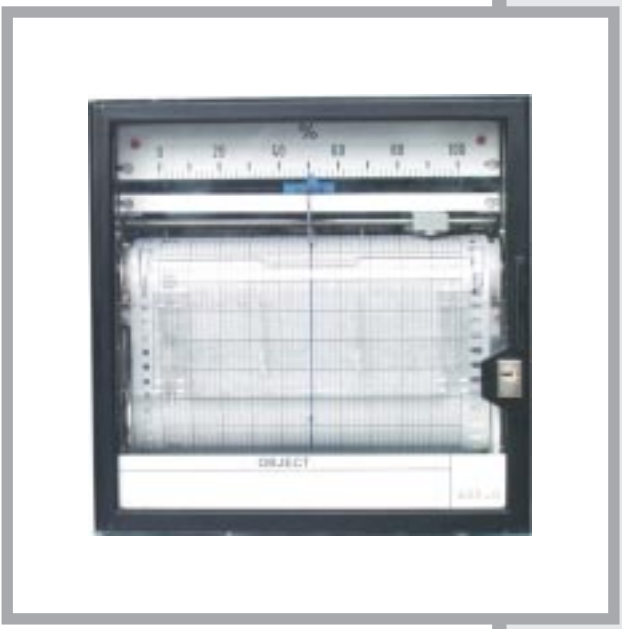
LUMEL

PANEL RECORDER

KR7 TYPE

MODBUS TRANSMISSION PROTOCOL



USER'S MANUAL

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1. APPLICATION

In order to obtain the information exchange, when using the serial link, one must choose the interface type and validate the interpretation way of transmitted data. The interface type defines only electrical transmission parameters and the way of the device connection.
Such features, as the possibility to service several devices, check the transmission correctness and the principles of access to the device, depend on the data interpretation.
The task of the protocol is to define which data is interpreted (permitted) and in which way they are interpreted.
A MODBUS asynchronous character transmission protocol has been implemented on the serial link of the **KR7** recorder. The parameter configuration of the **RS-485** serial link is described in the **KR7** recorder service manual.

Parameter set of the **KR7** recorder serial link:

• Recorder address	1 ...247
• Baud rate	300, 600, 1200, 1200, 2400, 4800, 9600, 14400, 19200, 28800, 38400, 57600, 115200 bit/s
• Mode	ASCII, RTU
• Information unit	ASCII: 8N1, 7N2, 7E1, 701 RTU:8N2, 8N1, 8E1,8O1
• Maximal turnaround time	100 ms (400 ms, in case of parameter writing)

2. DESCRIPTION OF THE MODBUS PROTOCOL

The MODBUS interface is a standard adopted by manufacturers of industrial devices for the asynchronous character exchange of information between different devices and measuring systems. It has such features as:

- Simple access rule to the link based on the „master-slave" principle,
- Protection of transmitted messages against errors,
- Confirmation of remote instruction realization and error signaling,
- Effective actions protecting against the system suspension,
- Taking advantage of the asynchronous character transmission.

Device controllers working in the **MODBUS** protocol can communicate with each other, taking advantage of the **master-slave** protocol type, in which only one device (the **master** - superior unit) can originate transactions (called „queries"), and others (slaves - subordinate units) respond only to the remote requested data from the master. The transaction is composed of the transmitted command from the **master** unit to the **slave** unit and of the response transmitted in the opposite direction. The response includes data demanded by the master or the confirmation of the command realization.

Master can transmit information to individual slaves or broadcast messages destined for all subordinate devices in the system (responses are not returned to broadcast queries from the master).

The format of transmitted information is as following:

- **master => slave:** device address, code representing the required command, data to be sent, control word protecting the transmitted message,
- **slave => master:** sender address, confirmation of the command realization, data required by the master, control word protecting the response against errors.

If the **slave** device detects an error when receiving a message, or cannot realize the command, it prepares a special message about the error occurrence and transmits it as a response to the **master**.

Devices working in the **MODBUS** protocol can be set into the communication using one of two transmission modes: **ASCII or RTU**. The user chooses the required mode, along with the serial port communication parameters (baud rate, information unit) during the configuration of any device.

In the **MODBUS** system, transmitted messages are placed into frames that are not related to serial transmission. These frames have a defined beginning and end. This enables the receiving device to reject incomplete frames and signal related errors with them.

Taking into consideration the possibility to operate in one of these two different transmission modes (ASCII or RTU), two frames have been defined.

Explanation of some abbreviations:

ASCII = American Standard Code for Information Interchange
RTU = Remote Terminal Unit
LRC = Longitudinal Redundancy Check
CRC = Cyclic Redundancy Check
CR = Carriage Return
LF = Line-Feed (character)
MSB = Most Significant Bit
Checksum = Control Sum

2.1. ASCII framing

In the ASCII mode each byte of information is transmitted as two ASCII characters. The basic feature of this mode is that it allows to long intervals between characters within the message (to 1 sec) without causing errors.

A typical message frame is shown below.

Start beginning index	Address	Function	Data	LRC check	End index
1 char /:/	2 chars	2 chars	*n* chars	2 chars	2 chars CR LF

In ASCII mode, messages start with a colon character („:" -ASCII 3Ah) and end with CR and LF characters. The frame information part is protected by the LRC code (Longitudinal Redundancy Check).

2.2. RTU Framing

In RTU mode, messages start and end with an interval lasting minimum 3.5 x (lasting time of a single character), in which a silence reigns on the link.

The simplest implementation of the mentioned time interval character times is a multiple measure of the character duration time at the set baud rate accepted on the link.

The frame format is shown below:

Start beginning index	Address	Function	Data	CRC check	End index
T1-T2-T3-T4	8 bits	8 bits	*n* x 8bits	16 bits	T1-T2-T3-T4

Start and end indexes are marked symbolically as an interval equal to four lengths of the index (information unit). The checking code consists of 16 bits and emerges as the result of CRC calculation (Cyclical Redundancy Check) of the frame contents.

2.3. Characteristic of frame fields.

Address field

The address field of a message frame contains two characters (in ASCII mode) or eight bits (in RTU mode).
Valid slave device addresses are in the range from 0 -247 . The master addresses the slave unit by placing the slave address in the frame address field. When the slave sends its response, it places its own address in the frame address field what enables the master to check which slave is responding.
The 0 address is used as a broadcast address recognized by all slave units connected to the bus.

Function field

The function code field of a message frame contains two characters in ASCII mode or eight bits in RTU mode. Valid codes are in the range from 1 - 255.
When a message is sent from a master to a slave device, the function code field tells the slave what kind of action to perform.
When the slave responds to the master, the function field is used to confirm the command execution or error signaling if the function code field cannot realize the command for any reason. to indicate either a normal (error-free) response or that some kind of error occurred.
The positive confirmation is realized through the placement of the command execution code on the function field.
In case of an error assertion, the slave returns a special code that is equivalent to the original function code with its most significant logic 1.
The error code is placed on the data field of the response frame.

Data field

The data field is constructed using sets of two hexadecimal digits, in the range of 00 to FF. These can be made from a pair of ASCII characters or from one RTU character, according to the network's serial transmission mode. The data field of messages sent from a master to slave devices contains additional information which the slave must use to take the action defined by the function code. This can include items like register addresses, number of bytes in data field , data, a.s.o. The data field can be non-existent (of zero length) in certain kinds of frames. That occurs always when the operation defined by the code does not require any parameters.

Error checking field

Two kinds of error-checking methods are used for standard MODBUS networks. The error checking field contents depends upon the method that is being used.

ASCII

When ASCII mode is used for character framing, the error checking field contains two ASCII characters. The error check characters are the result of a Longitudinal Redundancy Check (LRC) calculation that is performed on the message contents (without the beginning «»colon" and terminating CRLF characters). LRC characters are appended to the message, as the last field preceding the CR, LF characters.

RTU

When RTU mode is used for character framing, the error checking field contains a 16-bit value implemented as two 8-bit bytes. The error check value is the result of a Cyclical Redundancy Check Calculation (CRC) performed on a message contents. The CRC field is appended to the message as the last field in the message. When this is done, the low-order byte of the field is appended first, followed by the high-order byte. The CRC high-order byte is the last byte to be sent in the message.

2.4. LRC checking

The LRC is calculated by adding together successive 8-bit bytes of the message, discarding any carries, and then two is complementing the result. It is performed on the ASCII message field contents excluding the,,colon" character that begins the message, and excluding the CR, LF pair at the end of the message. The 8-bit value of the LRC sum is placed at the frame end as two ASCII characters, first the character containing the higher tetrad, and after it, the character containing the lower LRC tetrad.

2.5. CRC checking

The generating procedure of CRC is realized according to the following algorythm:

1. Load a 16-bit register with FFFFh. Call this the CRC register.
2. Exclusive OR the first 8-bit byte of the message with the low-order byte of the 16 bit CRC register, putting the result in the CRC register.
3. Shift the CRC register one bit to the right (towards the LSB), zero-filling the MSB. Extract and examine the LSB.
4. (If the LSB was O): Repeat step 3 (another shift) (If the LSB was 1): Exclusive OR the CRC register with the polynomial value A001h.
5. Repeat steps 3 and 4 until 8 shifts have been performed. When this is done, a complete 8-bit byte will have been processed.
6. Repeat steps 2 through 5 for the next 8-bit byte of the message. Continue doing this until all bytes have been processed.
7. The final contents of the CRC register is the CRC value.
8. When the CRC is placed into the message, its upper and lower bytes must be swapped as described below.

2.6. Character format during serial transmission

In the **MODBUS** protocol, characters are transmitted from the lowest to the highest bit. Organization of the information unit in the ASCII mode:
• 1 start bit,
• 7 data field bits,
• 1 even parity check bit (odd) or lack of even parity check bit,
• 1 stop bit at even parity check or 2 stop bits when lack of even parity check.

Organization of the information unit in the RTU mode:
• 1 start bit,
• 8 data field bits,
• 1 even parity check bit (odd) or lack of even parity check bit,
• 1 stop bit at even parity check or 2 stop bits when lack of even parity check.

2.7. Transaction interruption

In the master unit the user sets up the important parameter which is the „maximal response time on the query frame" after exceeding of which, the transaction is interrupted. This time is chosen such that each slave unit working in the system (even the slowest) normally will have the time to answer to the frame query. An exceeding of this time attests therefore about an error and such is treated by the master unit.
If the unit slave will find out a transmission error it does not accomplish the order and does not send any answer. That causes an exceeding of the waiting time after the query frame and the transaction interruption.

3. FUNCTION DESCRIPTION

In the KR7 recorder following protocol functions has been implemented:

Code	Signification
03	Reading of n-register
06	Writing of an individual register
16	Writing of n-registers
17	Slave device identification

3.1. Reading of n-registers (code 03)

Demand:
The function enables the reading of values included in registers in being addressed slave device. **Registers are 16 or 32-bit units, which can include numerical values bounded with changeable processes, and the like**. The demand frame defines the 16-bit start address and the number of registers to read-out.
The signification of the register contents with address data can be different for different device types.
The function is not accessible in the broadcast mode.

Example: Reading of 3 registers beginning by the register with the 6Bh address.

Address	Function	Register address Hi	Register address Lo	Number of registers Hi	Number of registers Lo	Checksum	
11	03	00	6B	00	03	7E	LRC

Answer:
Register data are packing beginning from the smallest address: first the higher byte, then the lower register byte.

Example: the answer frame

Address	Function	Number of bits regist 107 Hi	Value in the regist 107 Lo	Value in the regist 108 Hi	Value in the regist 108 Lo	Value in the regist 109 Hi	Value in the regist 109 Lo	Value in the	Checksum	
11	03	06	02	2B	00	00	00	64	55	LRC

3.2. Writing of values in the register (code 06)

Demand:
The function enables the modification of the register contents. It is accessible in broadcast mode.

Example:

Address	Function	Register address Hi	Register address Lo	Value Hi	Value Lo	Checksum	
11	06	00	87	03	9E	C1	LRC

Answer:
The correct answer to a value record demand in the register is the retransmission of the message after accomplishing the operation.

Example:

Address	Function	Register address Hi	Register address Lo	Value Hi	Value Lo	Checksum	
11	06	00	87	03	9E	C1	LRC

3.3. Writing in n-registers (code 16)

Demand:
The function is accessible in broadcast mode. It enables the modification of the register contents.

Example: Writing of two registers beginning from the register addressed 136.

Address	Function	Register address Hi	Register address Lo	Number of registers Hi	Number of registers Lo	Number of bytes	Data Hi	Data Lo	Data Hi	Data Lo	Checksum	
11	10	00	87	00	02	04	00	0A	01	02	45	LRC

Answer:

The correct answer includes the unit slave address, function code, starting address and the number of recorded registers.

Example:

Address	Function	Register address Hi	Register address Lo	Number of registers Hi	Number of registers Lo	Checksum	
11	10	00	87	00	02	56	LRC

3.4. Report identifying the device (code 17)

Demand:
This function enables the user to obtain information about the device type, status and configuration depending on this.

Example

Address	Function	Checksum	
11	11	DE	LRC

Answer:

The field ,,Device identifier" in the answer frame means the unique identifier of this class of device, however the other fields include parameters depended on the device type.

Example concerning the KR7 recorder

Slave address	Function	Number of bytes	Device identifier	Device state	Checksum
11	11	2	77	FF	66

4. ERROR CODES

When the master device is broadcasting a demand to the slave device then, except for messages in the broadcast mode, it expects a correct answer. After sending the demand of the master unit, one of the four possibilities can occur:

- If the slave unit receives the demand without a transmission error and can execute it correctly, then it returns a correct answer,
- If the slave unit does not receive the demand, no answer is returned. Timeout conditions for the demand will be fulfilled in the master device program.
- If the slave unit receives the demand, but with transmission errors (even parity error of checking sum LRC or CRC), no answer is returned. Timeout condition for the demand will be fulfilled in the master device program.
- If the slave unit receives the demand without a transmission error but cannot execute it correctly (e.g. if the demand is, the reading-out of a non-existent bit output or register), then it returns the answer including the error code, informing the master device about the error reason.

A message with an incorrect answer includes two fields distinguishing it from the correct answer.

1. The function code field:
In the correct answer, the slave unit retransmits the function code from the demand message in the field of the answer function code. All function codes have the most-significant bit (MSB) equal zero (code values are under 80h). In the incorrect answer, the slave unit sets up the MSB bit of the function code at 1. This causes that the function code value in the incorrect answer is exactly of 80h greater than it would be in a correct answer.
On the base of the function code with a set up MSB bit the program of the master device can recognize an incorrect answer and can check the error code on the data field.

2. The data field:
In a correct answer the slave device can return data to the data field (certain information required by the master unit). In the incorrect answer the slave unit returns the error code to the data field. It defines conditions of the slave device which had produced the error. An example considering a demand of a master device and the incorrect answer of the slave unit has been shown below. Data are in the hexadecimal shape.

Example: demand

Slave address	Function	Variable address H1	Variable address Lo	Number of variables Hi	Number of variables Lo	Checksum	
OA	01	04	A1	00	01	4F	LRC

Example: incorrect answer

Slave	Function	Error	Checksum	
OA	81	02	73	LRC

In this example the master device addresses the demand to the slave unit with No10 (OAh). The function code (01) serves to the read-out operation of the bit input state. Then, this frame means the demand of the status read-out of a one bit input with the address number: 1245 (04A1h).
If in the slave device there is no bit input with the given address, then the device returns the incorrect answer with the No 02 error code. This means a forbidden data address in the slave device.

Possible error codes and their meanings are shown in the table below.

Code	**Meaning**
01	Forbidden function
02	Forbidden data address
03	Forbidden data value
04	Damage in the connected device
05	Confirmation
06	Occupied, message removed
07	Negative confirmation
08	Error of memory parity

5. TABLE OF REGISTERS

• KR7 recorder identifier (set as a response to the identification function) : 0x83

• Type of registers („type” column)
  - int - 16-bit number
  - long - 32 bit number
  - float - floating point number (see the description below)
  - sfloat - floating point number (see the description below)
  - str[n] - sequence of characters with a maximal length of n characters, ended by a character with 0 code (together with the character of the end, the sequence of characters has n+1 length

• Access mode to registers
  - RW - for read-out and writing
  - RO - for read-out only
  - WO - for writing only

• Representation of floating point numbers (float IEEE 754)

byte:	0	1	2	3
	MMMMMMMM	MMMMMMMM	EMMMMMMM	SEEEEEEE

S - character bit (Sign bit)
E - exponent
M - mantissa
Register bytes of **float** type are sent in 3210 sequence
Register bytes of **sfloat** type are sent in 1032 sequence

Address	Type	Access	Name	Description
				Control registers
4000	int	RW	RSpass	Writing a value equal to the password set in the recorder will cause the unlocking of the access to the setting writing. When read-out: - if the access is unlocked - programmed password - if the access is locked - 10000.
4001	int	RW	Init	Writing of any value - execution of recorder initializing (should be done after the recorder parameters have been changed.)
4002	int	RW	Mode	Recorder working mode: 0 - recording 1 - recording stopped 2 - recording stopped by the binary signal (STOP BIN) 3 - marking of the recorder beginning (horizontal line on the paper tape) 4 - service mode (noupdatepomval) 5- service mode (noupdateoutval)
4003	int	RW	GoMinMax	Writing 0 - recording stopped and carriage set in the minimum position Writing 1 - recording stopped and the carriage set in the maximum position
4004	int	RO	isPrintText	The realization of the text printout order from registers 4005...4015 is going on.
4005... 4015	Str[21]	RW	PrintText	Text printout, the writing will cause the printout of the written text. If the printout order will not be accepted, then the error code will be returned (the error code is not returned when the text will not be printed because of a too high paper tape feed or because of the printout of a task of higher priority). Admissible character codes are inserted in the KR7 user's manual (p.18)

RECORDER PARAMETERS

Address	Type	Access	Name	Description
				System parameters
4110	int	RW	Sys.Pass	Password
4111	int	RW	Sys'Speed	Internal tape feed speed: 0 - 0, 1 - 5, 2 - 10, 3 - 20, 4 - 60, 5 - 120, 6 - 300, 7 - 600, 8 - 1200, 9 - 3600.
4112	int	RW	Sys.SpeedExt	External tape feed speed: 0 - off, 1 - 0, 2 - 5, 3 -10, 4 - 20, 5 - 60, 6 - 120, 7 - 300, 8 - 600, 9 - 1200, 10 - 3600.
4113	int	RW	Sys.Lang	Menu description language: 0 - English, 1 - German, 2 - French, 3 - Italien
4114	int	RW	Syst.Unit	Temperature unit: 0 - °C, 1 - °F
4115	int	RW	Syst.Freq	Supplying network frequency: 0 - 50 Hz, 1 - 60 Hz
4116	int	RW	Sys.Daylight	Automatic change of summer/winter season time: 0 - OFF, 1 - ON
4117... 4121	Str[8]	RW	Sys.ScaUnit	Scale description unit. Admissible character codes are inserted in the KR7 User's Manual.
4122	Long	RW	Syst.Time	Time in the form of number of seconds from the 0:00:00 hour, January 1, 1970
4123	-	-	-	
				Parameters of the communication interface
4140	int	RW	Int.Mode	Transmission mode: 0 - ASCII 8N1, ASCII 7N2, 2 - ASCII 7E1, 3 - ASCII 7O1, 4 - RTU 8N2, 5 - RTU 8N1, 6 - RTU 8E1, 7 - RTU 801
4141	int	RW	Int.Baud	Baud rate: 0 - 300, 1 - 600, 2 - 1200, 3 - 2400, 4 - 4800, 5 - 9600, 6 - 14400, 7 - 19200, 8 - 28800, 9 - 38400, 10 - 115200
4142	int	RW	Int.ID	Identification number (1...247)
				Parameters of tape description
4150	int	RW		Printing period of the current description line: 0 - OFF, 1 - 15 min, 2 - 30 min, 3 - 1 hour, 4 - 2 hours, 5 - 3 hours, 6 - 6 hours, 7 - 12 hours, 8 - 24 hours.
4151	int	RW		Information range in the current description line: 0 - in short, 1 - full
4152	int	RW		Tape description after alarm occurrence: 0 -OFF, 1 - ON
4153	int	RW		Period of the digital measurement result printout: as for 4150 register

				Measuring parameters
4170	int	RW	M.RW	Writing 0 - read-out of the „M.”record (one must execute before 4171...4187 registers read-out) Writing 1 - writing of the „M.” record (one must execute after the writing of 4171...4187 registers writing or writing in group the 4170...4187 registers) Before the writing of the „M.” record (writing 1 into the 4170 register), values in 4171...4187 registers should be correct, admissible for the defined input signal in the 4171 register.
4171	int	RW	M.Type	Kind of input signal: 0 - Voltage < 10 V 1 - Voltage > 10 V 2 - Current 3 - J (FeCu-Ni) 4 - K (NiCr-NiAl) 5 - N (NiCrSi-NiSi) 6 - E (NiCr-CuNi) 7 - R (PtRh13-Pt) 8 - S (PtRh10-Pt) 9 - T (Cu-CuNi) 10 - B (PtRh30-PtRh6) 11 - Pt100 12 - Pt500 13 - Pt1000 14 - Ni100 15 - Cu100 16 - Potentiometric transmitter 17 - Resistance transmitter
4172	int	RW	M.CompTyp	Compensation type of reference cold junction: 0 - internal (ACJC) 1 - external (CJ)
4173	-	-	-	
4174	float	RW	M.CJ	Temperature of external compensation (CJ) (always in $0^{o}C$)
4175	-	-	-	
4176	float	RW	M.LR	Line resistance [Ω]
4177	-	-	-	
4178	float	RW	M.PR	Resistance of the potentiometric transmitter [Ω]
4179	-	-	-	
4180	float	RW	M.InpMin	Input signal minimum (temperature always in ^{o}C)
4181	-	-	-	
4182	float	RW	M.InpMax	Input signal maximum (temperature always in ^{o}C)
4183	-	-	-	

4184	float	RW	M.ScaMin	Scale description - min
4185	-	-	-	
4186	float	RW	M.ScaMax	Scale description - max
4187	-	-	-	
				Parameters of the retransmission output
4190	int	RW	LOut.RW	Writing 0 - read-out of the „LOut"record (must be executed before 4191...4196 registers read-out) Writing 1 - writing of the „LOut." record (must be executed after the writing of 4191...4196 registers writing or writing in group the 4190...4196 registers)
4191	-	-	-	
4192	float	RW	LOut.Min	Minimal retransmission signal
4193	-	-	-	
4194	float	RW	LOut.Max	Maximal retransmission signal
4195	-	-	-	
4196	int	RO	Lout.Type	Type of the retransmission output: 0 - without output 1 - Voltage 0 -10 V 2 - Current 0...5 mA 3 - Current 0...20 mA
				Alarm parameters
4200	float	RW	Ala.Val[0]	Relay 1 - Value of the alarm threshold
4201	-	-	-	
4202	float	RW	Ala.Hyst[0]	Relay 1 - Alarm hysteresis
4203	-	-	-	
4204	int	RW	Ala.Act[0]	Relay 1 - Alarm activity (0 - OFF., - ON)
4205	-	-	-	
4206	float	RW	Ala.Val[1]	Relay 2 - Alarm threshold value
4207	-	-	-	
4208	float	RW	Ala.Hyst[1]	Relay 2 - Alarm hysteresis
4209	-	-	-	
4210	int	RW	Ala.Act[1]	Relay 2 - Alarm activity (0 -OFF, 1 - ON)
				Recorder calibration parameters
4220	int	RW	Cal.Min	Recorder calibration - 0%
4221	int	RW	Cal.Max	Recorder calibration - 100%
4222	int	RW	CalSave	Writing 1 - writing of calibrating parameters

PROCESS DATA

Address	Type	Access	Name	Description
7000	float	RO	MeasureInp	Measurement value in input units
7001	-	-	-	
7002	float	RO	MeasureSca	Measurement value in scale units
7003	-	-	-	
7004	float	RO	MeasureStat	Measurement status: 0 - lack of measurement 1 - correct measurement 2 - overrunning of the upper transducer range 3 - overrunning of the lower transducer range 4 - break of sensor
7005	-	-	-	
7006	float	RO	Ala0Stat	0 - relay 1 switched off. 1 - relay 2 switched on
7007	-	-	-	
7008	float	RO	Ala1Stat	0 - relay 2 switched off. 1 - relay 1 switched on
7009	-	-	-	
7010	float	RO	TempCJ	Temperature of cold junctions
7011	-	-	-	
7012	float	RW	LineOut	Controllability of the retransmission output (in output units)
7013	-	-	-	
				Doubled registers 7000..7013, float type
7100	sfloat	RO	MeasureInp	See 7000 register description
7101	-	-	-	
7102	sfloat	RO	MeasureSca	See 7002 register description
7103	-	-	-	
7104	sfloat	RO	MeasureStat	See 7004 register description
7105	-	-	-	
7106	sfloa	tRO	Ala0Stat	See 7006 register description
7107	-	-	-	
7108	sfloat	RO	Ala1Stat	See 7008 register description
7109	-	-	-	
7110	sfloat	RO	TempCJ	See 7010 register description
7111	-	-	-	
7112	sfloat	RW	LineOut	See 7012 register description
7113	-	-	-	
				Doubled registers 7000..7013, float type, 32-bit addressed
7500	float	RO	MeasureInp	See 7000 register description
7501	float	RO	MeasureSca	See 7002 register description
7502	float	RO	MeasureStat	See 7004 register description

7503	float	RO	Ala0Stat	See 7006 register description
7504	float	RO	Ala1Stat	See 7008 register description
7505	float	RO	TempCJ	See 7010 register description
7506	float	RW	LineOut	See 7012 register description
				Doubled registers 7000..7013, sfloat type, 32-bit addressed
7600	sfloat	RO	MeasureInp	See 7000 register description
7601	sfloat	RO	MeasureSca	See 7002 register description
7602	sfloat	RO	MeasureStatS	ee 7004 register description
7603	sfloat	RO	Ala0Stat	See 7006 register description
7604	sfloat	RO	Ala1Stat	See 7008 register description
7605	sfloat	RO	TempCJ	See 7010 register description
7606	sfloat	RW	LineOut	See 7012 register description

MEASURING BUFFER

				Current value of measurement and time
7994	-	-	-	
7995	int	RO	Cur.Flags	Bit 0..1: 0 - winter time, 1 - summer time, 2 - automatic change of time is off Bit 8..10: see description of 7004 register Bit 12: see description of 7006 register Bit 13: see description of 7008 register
7996	long	RO	Cur.Time	Measurement time (format as for 4112 register)
7997	-	-	-	
7998	float	RO	Cur.Value	Measurement value in scale units
7999	-	-	-	
				Measuring buffer from the newest position
8000	int	RO	PosNew	Position of the newest data in the measuring buffer
8001	int	RO	New.Flags	See the description of the 7995 register
8002	long	RO	New.Time	Measurement time (format as for the 4122 register)
8003	-	-	-	
8004	float	RO	New.Value	Measurement value in scale units
8005	-	-	-	
8006	int	RO	PosNew	See the description of the 8000 register
8007	int	-	PosOld	Read-out - position of the higher data in the measuring buffer. Writing - set the position in the buffer (n) on the position PosOld + written value.

				Measuring buffer from the selected position
8008	int	RW	n	Position in the buffer
8009	int	RO	Buf[n].Flags	See the description of the 8001 register
8010	long	RO	Buf[n].Time	See the description of the 8002 register
8011	-	-	-	
8012	float	RO	Buf[n].Value	See the description of the 8004 register
8013	-	-	-	
				Measuring buffer from the selected position, with automatic transition on the next buffer position while read out
8014	int	RO	n	The position in the buffer, while read out this register is automatically increased of 1
8015	int	RO	Buf[n].Flags	See the description of the 8001 register
8016	long	RO	Buf[n].Time	See the description of the 8002 register
8017	-	-	-	
8018	float	RO	Buf[n].Value	See the description of the 8004 register
8019	-	-	-	
8020... 8074			Buf[n+1]... Buf[n+9]	8014...8019 registers are nine time repeated. Reading out by groups 8008...8074 registers, one can obtain 10 successive positions from the measuring buffer (8014...8074 registers) and the contents of the previously read out position (8008...8013) registers) which we can used e.g. in order to check the data continuity)

INFORMATION REGISTERS

Address	Type	Access	Name	Description
9000	ulong	RO	SerialNb	Recorder serial number
9001	-	-	-	
9002	int	RO	Version	KR7 programming version (version *1000)
9003	int	RO	SetupIsData	1 - in the Flash memory there are parameters on order
9004	int	RO	CalibIsData	1 - in the Flash memory there are calibrating parameters
9005	int	RW	EEPROMstat	State of the EEPROM memory:: 0x1234 - OK., 0x1111 - BAD, 0xFFFF - Empty
9006	int	RO	IsPrinter	0 - The recorder does not includes the printer module or it is damaged 1 - the recorder includes the printer module.

TECHNOLOGICAL AND SERVICE REGISTERS

Address	Type	Access	Name	Description
9200... 9252	-	-	-	Technological registers
30000... 30001	-	-	-	Service registers

APPENDIX A
CALCULATION OF THE CHECKSUM

In this appendix some examples of function in the C language calculating the LRC checksum for ASCII mode and the CRC checksum for the RTU mode have been shown.

The function for LRC calculation has two arguments:

*unsigned char *outMsg;*	- Pointer for the communication buffer, including binary data from which one must calculate LRC.
unsigned short usDataLen;	- Number of bytes in the communication buffer.

The function returns LRC of unsigned char type.

```
static unsigned char LRC(outMsg, usDataLen)
unsigned char *outMsg;                    /* buffer to calculate LRC */
unsigned short usDataLen;                 /* number of bytes in the buffer 7
{
unsigned char uchLRC = 0;                 /* initialization of LRC */
 while (usDataLen—)
uchLRC += *outMsg++;                      /* add the buffer byte without transfer*
return ((unsigned char)(-(char uchLRC))); /* return the sum in the completion
                                             code up two*/
}
```

An example of function in C language calculating the CRC sum is presented below. All possible values of CRC sum are placed in two tables.
The first table includes the highest byte of all 256 possible values of the 16-bit CRC field, however the second table includes the lowest byte.
The assignment of the CRC sum through table indexing is further more rapid than the calculation of a new CRC value for each sign of the communication buffer.

Note: The below function represents bytes of the sum CRC higher/lower, and this way the CRC value returned by the function can be directly placed in the communication buffer.

The function serving to calculate CRC has two arguments:

*unsigned char *puchMsg;* - Pointer for the communication buffer, including binary data from which one must calculate LRC.

unsigned short usDataLen; - Number of bytes in the communication buffer.

The function returns CRC of *unsigned short* type.

```
unsigned short CRC16(puchMsg, usDataLen)
unsigned char *puchMsg;                 /* buffer to calculate CRC */
unsigned short usDataLen;               /*Number of bytes in the buffer */
{
unsigned char uchCRChi = OxFF;          /* initialisation of the higher CRC byte*/
unsigned char uchCRClo = OxFF;          /* initialisation of the lower CRC byte */
while (usDataLen—)
{       uindex = uchCRChiA *puchMsg++;          /* CRC calculation*/
        uchCRChi = uchCRClo A crc_hi[ulndex];
        uchCRClo = crc_lo[ulndex];
}
retum(uchCRChi”8 \ uchCRClo);
}
```

```
//table of the older CRC byte /
const unsigned char crc_hi[]={
0x00,  0xC1,  0x81,  0x40,  0x01,  0xC0,  0x80,  0x41,  0x01,  0xC0,  0x80,  0x41,  0x00,  0xC1,  0x81,
0x40,  0x01,  0xC0,  0x80,  0x41,  0x00,  0xC1,  0x81,  0x40,  0x00,  0xC1,  0x81,  0x40,  0x01,  0xC0,
0x80,  0x41,  0x01,  0xC0,  0x80,  0x41,  0x00,  0xC1,  0x81,  0x40,  0x00,  0xC1,  0x81,  0x40,  0x01,
0xC0,  0x80,  0x41,  0x00,  0xC1,  0x81,  0x40,  0x01,  0xC0,  0x80,  0x41,  0x01,  0xC0,  0x80,  0x41,
0x00,  0xC1,  0x81,  0x40,  0x01,  0xC0,  0x80,  0x41,  0x00,  0xC1,  0x81,  0x40,  0x00,  0xC1,  0x81,
0x40,  0x01,  0xC0,  0x80,  0x41,  0x00,  0xC1,  0x81,  0x40,  0x01,  0xC0,  0x80,  0x41,  0x01,  0xC0,
0x80,  0x41,  0x00,  0xC1,  0x81,  0x40,  0x00,  0xC1,  0x81,  0x40,  0x01,  0xC0,  0x80,  0x41,  0x01,
0xC0,  0x80,  0x41,  0x00,  0xC1,  0x81,  0x40,  0x01,  0xC0,  0x80,  0x41,  0x00,  0xC1,  0x81,  0x40,
0x00,  0xC1,  0x81,  0x40,  0x01,  0xC0,  0x80,  0x41,  0x01,  0xC0,  0x80,  0x41,  0x00,  0xC1,  0x81,
0x40,  0x00,  0xC1,  0x81,  0x40,  0x01,  0xC0,  0x80,  0x41,  0x00,  0xC1,  0x81,  0x40,  0x01,  0xC0,
0x80,  0x41,  0x01,  0xC0,  0x80,  0x41,  0x00,  0xC1,  0x81,  0x40,  0x00,  0xC1,  0x81,  0x40,  0x01,
0xC0,  0x80,  0x41,  0x01,  0xC0,  0x80,  0x41,  0x00,  0xC1,  0x81,  0x40,  0x01,  0xC0,  0x80,  0x41,
0x00,  0xC1,  0x81,  0x40,  0x00,  0xC1,  0x81,  0x40,  0x01,  0xC0,  0x80,  0x41,  0x00,  0xC1,  0x81,
0x40,  0x01,  0xC0,  0x80,  0x41,  0x01,  0xC0,  0x80,  0x41,  0x00,  0xC1,  0x81,  0x40,  0x01,  0xC0,
0x80,  0x41,  0x00,  0xC1,  0x81,  0x40,  0x00,  0xC1,  0x81,  0x40,  0x01,  0xC0,  0x80,  0x41,  0x01,
0xC0,  0x80,  0x41,  0x00,  0xC1,  0x81,  0x40,  0x00,  0xC1,  0x81,  0x40,  0x01,  0xC0,  0x80,  0x41,
0x00,  0xC1,  0x81,  0x40,  0x01,  0xC0,  0x80,  0x41,  0x01,  0xC0,  0x80,  0x41,  0x00,  0xC1,  0x81,
0x40
};
```

```
//table of the lower CRC byte /
const unsigned char crc_lo[]={

0x00,  0xC0,  0xC1,  0x01,  0xC3,  0x03,  0x02,  0xC2,  0xC6,  0x06,  0x07,  0xC7,  0x05,  0xC5,  0xC4,
0x04,  0xCC,  0x0C,  0x0D,  0xCD,  0x0F,  0xCF,  0xCE,  0x0E,  0x0A,  0xCA,  0xCB,  0x0B,  0xC9,  0x09,
0x08,  0xC8,  0xD8,  0x18,  0x19,  0xD9,  0x1B,  0xDB,  0xDA,  0x1A,  0x1E,  0xDE,  0xDF,  0x1F,  0xDD,
0x1D,  0x1C,  0xDC,  0x14,  0xD4,  0xD5,  0x15,  0xD7,  0x17,  0x16,  0xD6,  0xD2,  0x12,  0x13,  0xD3,
0x11,  0xD1,  0xD0,  0x10,  0xF0,  0x30,  0x31,  0xF1,  0x33,  0xF3,  0xF2,  0x32,  0x36,  0xF6,  0xF7,
0x37,  0xF5,  0x35,  0x34,  0xF4,  0x3C,  0xFC,  0xFD,  0x3D,  0xFF,  0x3F,  0x3E,  0xFE,  0xFA,  0x3A,
0x3B,  0xFB,  0x39,  0xF9,  0xF8,  0x38,  0x28,  0xE8,  0xE9,  0x29,  0xEB,  0x2B,  0x2A,  0xEA,  0xEE,
0x2E,  0x2F,  0xEF,  0x2D,  0xED,  0xEC,  0x2C,  0xE4,  0x24,  0x25,  0xE5,  0x27,  0xE7,  0xE6,  0x26,
0x22,  0xE2,  0xE3,  0x23,  0xE1,  0x21,  0x20,  0xE0,  0xA0,  0x60,  0x61,  0xA1,  0x63,  0xA3,  0xA2,
0x62,  0x66,  0xA6,  0xA7,  0x67,  0xA5,  0x65,  0x64,  0xA4,  0x6C,  0xAC,  0xAD,  0x6D,  0xAF,  0x6F,
0x6E,  0xAE,  0xAA,  0x6A,  0x6B,  0xAB,  0x69,  0xA9,  0xA8,  0x68,  0x78,  0xB8,  0xB9,  0x79,  0xBB,
0x7B,  0x7A,  0xBA,  0xBE,  0x7E,  0x7F,  0xBF,  0x7D,  0xBD,  0xBC,  0x7C,  0xB4,  0x74,  0x75,  0xB5,
0x77,  0xB7,  0xB6,  0x76,  0x72,  0xB2,  0xB3,  0x73,  0xB1,  0x71,  0x70,  0xB0,  0x50,  0x90,  0x91,
0x51,  0x93,  0x53,  0x52,  0x92,  0x96,  0x56,  0x57,  0x97,  0x55,  0x95,  0x94,  0x54,  0x9C,  0x5C,
0x5D,  0x9D,  0x5F,  0x9F,  0x9E,  0x5E,  0x5A,  0x9A,  0x9B,  0x5B,  0x99,  0x59,  0x58,  0x98,  0x88,
0x48,  0x49,  0x89,  0x4B,  0x8B,  0x8A,  0x4A,  0x4E,  0x8E,  0x8F,  0x4F,  0x8D,  0x4D,  0x4C,  0x8C,
0x44,  0x84,  0x85,  0x45,  0x87,  0x47,  0x46,  0x86,  0x82,  0x42,  0x43,  0x83,  0x41,  0x81,  0x80,
0x40
};
```

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